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Use of the Precaution Adoption Process Model to examine predictors of osteoprotective behavior in epilepsy

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Summary In the neurology literature it is well established that anti-epileptic drugs (AEDs) lead to bone loss (osteopenia and osteoporosis). Several large epidemiologic studies have found twice the fracture rate in persons with epilepsy compared to the non-epilepsy population. While an increasing level of awareness for preventative measures and screening by neurologists and primary care physicians are recommended, so far no one has attempted to address how knowledge related to calcium and exercise, health beliefs (based on the Health Belief Model) and self-efficacy (confidence in abilities) impact osteoprotective behaviors in epilepsy, based on the Precaution Adoption Process Model (PAPM). The seven-stage PAPM, unlike other health behavior theories where a person is either practicing or not practicing the behavior, conceptualizes behavior change as dynamic and occurring over time. Validated instruments were used to assess knowledge, health beliefs, self-efficacy and stages of the precaution adoption process for four osteoprotective behaviors. For dietary calcium; exercise knowledge and calcium self-efficacy predicted higher stages of precaution adoption. For calcium supplements; age perceived susceptibility for osteoporosis and perceived benefits of calcium predicted higher stages. Exercise adoption stage was most predicted by exercise knowledge and health motivation. For DEXA screening adoption; age and perceived susceptibility predicted higher stages. This study provides hints how persons with epilepsy could be influenced to move from the unaware/unengaged positions into to the stages of adoption and maintenance for osteoprotective behaviors.

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Introduction

An estimated 1.5 million people suffer a bone-disease related fracture annually in the U.S.[1] Two recent large cohort studies found double the fracture incidence in persons with epilepsy when compared to a non-epilepsy population.[2,3] It has been demonstrated that bone loss can occur after as little as 2 years of antiepileptic drug (AED) exposure.[4] A survey by Epilepsy Action found 75% of members reported never being told about osteoporosis/osteomalacia as a possible side effect of long-term (>5 years) use of AEDs. Of those who were informed of bone health issues, their epilepsy specialist was reported as the primary source of this information.[5] Ninety percent of patients reported wanting more information about epilepsy and 75% reported they were not given enough information about the side effects of antiepileptic drugs.[6]

Adequate calcium intake in adolescence can result in a 5—10% difference in peak bone mass and may be able to reduce the risk of hip fracture by 50%.[7] Regular physical activity increases muscle and bone strength, increases lean muscle and decreases body fat.[8] Based on results of the Centers for Disease Control's Behavioral Risk Surveillance System in 2001, only 45% of US adults surveyed engaged in physical activity at recommended levels (i.e. $\geq$20 min per day, $\geq$3 days per week).[9]

Persons with epilepsy report significantly less physical activity and higher rates of obesity,[10] however they do believe exercise may improve their medical treatment.[11] A majority of persons with epilepsy have no adverse effects from exercise and up to 36% have reported that regular exercise contributed to better seizure control.[12] Since the benefits of exercise for osteoporosis do not persist without regular participation, the challenge is to not only increase adoption in those who are sedentary but also to develop education and programs that promote the maintenance of exercise once it has been established.[13]

Osteoporosis knowledge

Educational interventions focused on osteoporosis have been able to increase knowledge but have not resulted behavior change.[14] Women diagnosed with osteoporosis score higher than a general sample on osteoporosis knowledge tests,[15] however scores were *not* associated with calcium intake or weight bearing exercise. Studies of men have also found poor knowledge.[16] Overall, level of education seems to be the best predictor of knowledge scores.[17]

Perceived susceptibility for osteoporosis

The study of behavioral aspects related to osteoporosis prevention, diagnosis and treatment in the general population have revealed that most people at risk do not view osteoporosis with concern.[18] This is disconcerting since one out of every two Caucasian women may experience an osteoporotic fracture in their lifetime.[19] Studies of non-Caucasian populations have found similar concerns relating to osteoporosis knowledge and health behavior.[20,21]

Studies of men have also found a lack of perceived susceptibility with few engaging in preventative behaviors such as weight-bearing exercise, increasing dietary calcium or supplementation.[16] The rate of fracture related mortality, 1-year post-hip fracture, is double in men compared to women.[16,22] Males on AEDs have been found to have a 1.8% annual loss of bone mineral density, yielding a 2.5-fold increased prevalence of bone loss at the hip when compared to the healthy U.S. male population.[23]

Health behavior models/theories

Stages of change models

A "stages of change" model posits that preventative behaviors are adopted through a series of decisional changes. Stages of change models work in a variety of populations,[24] age groups[25] as well as for specific health concerns such as osteoporosis,[26] calcium intake[27] and exercise.[28,29] Stage matched interventions have improved progress towards higher stages of adoption in employee exercise programs.[30] Classifying people by stage of adoption has been useful in that subjects grouped by stage tend to share similar knowledge, beliefs, attitudes and perceived barriers for the specific behavior and they often have a different pattern of these attributes than people in other stages.[31]

The Precaution Adoption Process Model

The Precaution Adoption Process Model (PAPM), described in Fig. 1,[32] is based on the stages of change concept. The seven-stage PAPM, unlike other health behavior theories where a person is either practicing or not practicing the behavior, conceptualizes behavior change as dynamic and occurring over time.[33] The PAPM (and other stage models) suggest that people at different points in the precaution adoption process behave in qualitatively different ways and that the types of interventions and information

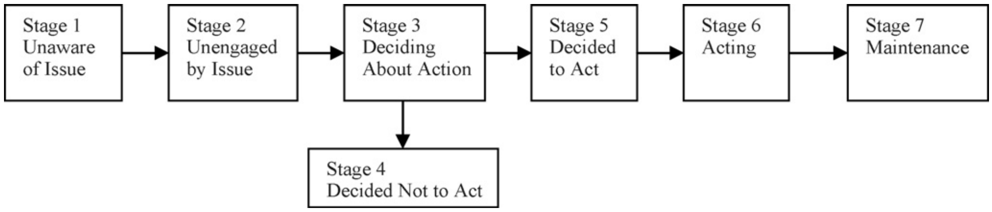

Figure 1 Stages of the Precaution Adoption Process Model (*source*: Ref. [32]).

needed to move people closer to action varies from stage to stage.[34] Although the PAPM does not provide a fixed set of variables that differentiate between stage or foster progression from stage to stage,[35] it is thought that between stages an individual's health beliefs and perceptions (perceived susceptibility, perceived severity, barriers, benefits and self-efficacy) are critical for action. People in action and maintenance have often changed their behavior and in these stages self-efficacy (confidence in abilities) is likely based on experience rather than perception.[36]

The model assumes people move through the sequence in order, without skipping stages. However, there is no minimum amount of time one will spend in each stage and people can regress in their stage.[37] The PAPM has been used to study adoption of behaviors related to osteoporosis,[33,38,39] mammography screening[40] and home radon testing.[37] In a study of postmenopausal women recently admitted for a low-impact fracture, 62% were in Stage 1 or 2 of the PAPM and only a previous diagnosis of osteoporosis was associated with a more advanced stage of patient readiness to accept treatment after a fracture.[39] Another reason for determining where people are in the stage of a behavior has been in the benefits of utilizing education programs and materials designed to move people along in the stage process.[41] Traditionally, many programs (i.e. smoking cessation) are designed for the small number of people who are already prepared to change their behavior or adopt a new behavior.

Health Belief Model

The Health Belief Model (HBM), seen in Fig. 2,[42] has been used to explain health behavior in osteoporosis research.[39,43] The HBM states that perception of a health behavior threat is influenced by general health values (interest and concern about health), beliefs about vulnerability to a health threat and beliefs about the consequences of a health problem. Once an individual perceives a threat to their health, has been cued (internally or externally) to action, and their perceived benefits outweighs the perceived barriers, then the individual is most likely to undertake a recommended preventive health action. Demographic variables, perceived threat, and cues to action (family history, screening test results or discussions with a health professional) act as modifying factors.

Self-efficacy

Self-efficacy beliefs (confidence in abilities) determine how people feel, think, motivate themselves and behave.[44] Individuals with greater self-efficacy beliefs are more likely to engage in healthy behaviors, maintain these behaviors and to recover from

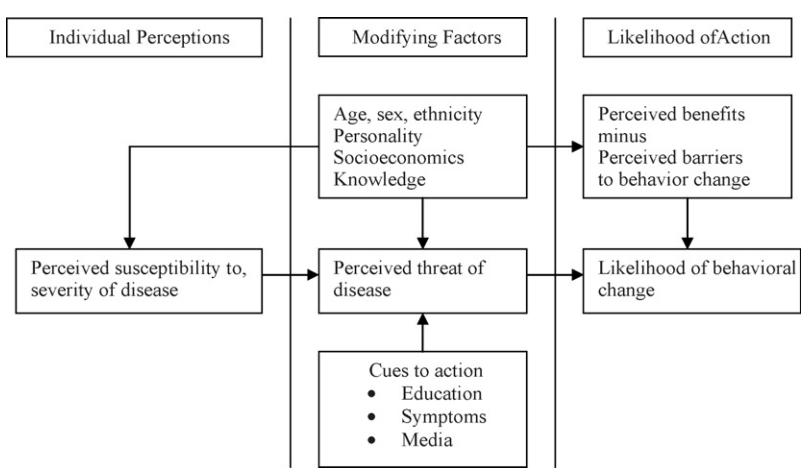

Figure 2 The Health Belief Model (diagram source: Ref. [42]).

setbacks.[45] Baseline self-efficacy and changes in self-efficacy are associated with future health status.[46] The literature supports the importance of self-efficacy in influencing and predicting health behavior in the areas of smoking cessation, coronary artery disease, weight loss, pulmonary disease, arthritis and diabetes.[47] It follows that a similar pattern may exist in persons with epilepsy since it is often a chronic condition.

Self-efficacy has been incorporated into a stage model for calcium intake[27] and exercise[28] showing it predicts strongly stage membership with those in the lower stages having the lowest self-efficacy scores and those in maintenance having the highest. Self-efficacy is considered one of the most consistent predictors of adherence to exercise.[48]

Epilepsy self-efficacy

Chronic disease is a major cause of disability and has been estimated to account for 70% of all health care expenditures. It is also one of the main reasons people seek health care.[49] Only one-third of patients are believed to adhere to their prescribed medical regimens.[47] Self-management tasks are extensive—they involve medical management (taking medication or following a specific diet), maintaining, changing and creating new behaviors as well as the emotional effects of a chronic condition which changes one's view of the future.[46] Self-management of epilepsy, like other chronic health conditions, requires a high level of self-efficacy.[50]

To date, in the study of bone loss in epilepsy, there has been little emphasis on the psychosocial aspects related to the adoption of osteoprotective behavior. Our plan was to strategically take validated health behavior concepts (the Health Belief Model and self-efficacy) along with domain specific knowledge scales (calcium and exercise) in order to determine their ability to discriminate people among the stages of change based on the Precaution Adoption Process Model. In the clinical setting, patient education based upon principles of health behavior, may improve opportunities for prevention related to dietary calcium, calcium supplements, physical exercise and dual emitting X-ray absorptiometry (DEXA) screening. Previous research has found that few people are in the same stage when looking at multiple health behaviors.[51]

On the basis of established health behavior theories (the Health Belief Model and self-efficacy) we believed persons in the higher stages of the PAPM would perceive more benefits and less barriers for osteoprotective behaviors, as well as a greater level of perceived susceptibility for osteoporosis. We also theorized that persons in the higher stages of the PAPM would have higher levels of perceived self-efficacy related to osteoprotective behaviors. On the basis of previous studies we also expected to see persons in the more advanced stages (those who have adopted the behavior) to possess greater knowledge of calcium and exercise than those in lower stages (those who have not thought about adopting a specific behavior).

Methods

Ninety-four epilepsy clinic subjects, age 18 years or older (range 19—78), participated in the study. Subjects were recruited from the Temple University School of Medicine Department of Neurology outpatient clinic. Data collection took place over a 6-month period. Inclusion criteria included patients age 18 or older with a diagnosis of epilepsy. Exclusion criteria included patients with mental retardation, learning disability, Alzheimer's, dementia or schizophrenia. Five hundred patients (seen in the past 4 years) were deemed eligible to complete the survey based on chart review. Eighty-three patients were approached to participate at clinic visits and 142 surveys were mailed to eligible patients who were not coming in for an office visit in the upcoming months. The response rate to our questionnaire was 42%. Of those approached at clinic 27 (33%) completed surveys and of those who were mailed surveys 67 (47%) completed and mailed them back. The Temple University Institutional Review Board approved this study and written informed consent was obtained from each participant.

Instruments

Subjects completed seven sections in the questionnaire. A questionnaire based on the Precaution Adoption Process Model (PAPM) was adapted from previous studies[33,38] and used to assess the PAPM stage for four preventative behaviors: dietary calcium, calcium supplements, exercise and bone density screening by dual energy X-ray absorptiometry (DEXA).

The osteoporosis knowledge test (OKT) is a 24-item multiple-choice test designed by Kim et al.[52] to measure knowledge of risk factors for osteoporosis and strategies for prevention related to exercise and calcium. There are two sub-scales for the OKT: *calcium* and *exercise*. OKT *exercise* subscale internal consistency coefficient (a measure of reliability) called Cronbach's alpha was .69. The OKT *calcium* subscale Cronbach's alpha was .72. Validity of the OKT was evaluated by factor analysis and discriminant function analysis.[52]

The Osteoporosis Health Behavior Scale (OHBS) was designed by Kim et al.[53] to assess the perception of risk related to osteoporosis and health beliefs related into prevention based on the Health Belief Model, seen in Fig. 2.[53] The OHBS has 42 items grouped in seven subscales: perceived susceptibility of osteoporosis, perceived seriousness of osteoporosis, barriers to calcium intake, barriers to exercise, benefits of calcium intake, benefits of exercise and health motivation. Each item is scored using a Likert scale with one as "strongly disagree" to five for "strongly agree". Cronbach's alpha reliability coefficients ranged from .61 (health motivation) to .80 (susceptibility) in an early development and evaluation study.[52] Updated reliability coefficients were found to be .76 for the OHBS Calcium subscale and .77 for the OHBS exercise subscale.

The Osteoporosis Self-Efficacy Scale (OSES) was designed by Horan et al.[54] to measure the level of confidence for an individual in undertaking osteoporosis preventive measures. The questionnaire has twelve items separated in two sub-scales: OSES *calcium* and OSES *exercise*. The confidence on each item is rated by placing an "X" on a 100 mm line that has a range from 0 as "not at all confident" up to 100 as "very confident". Cronbach's alpha for the *calcium* and *exercise* sub-scales was .93 and .94, respectively. Validity of the 12 item OSES was evaluated by factor analysis and discriminate function analysis.

The Epilepsy Self-Efficacy Scale (ESES) is a 33 question, Likert scale survey. Each item is rated on an 11-point scale of 0—10, with 0 being "I cannot do at all" and 10 being "Sure I can do". The ESES measures the degree of confidence that individuals have in their ability to successfully perform tasks in the areas of medication management, seizure control and general epilepsy management.[50,55—57] Total score ranges from 0 to 330, with higher scores indicating higher levels of self-efficacy. Content and construct validity have been assessed and ratings of individual items demonstrated 94% agreement among an expert panel, which included Bandura, the originator of self-efficacy theory. Cronbach's alpha for several studies ranged from .93 to .94.[55]

Each subject also completed a demographic questionnaire. Information requested included age, gender, ethnicity, marital status, education, yearly income, working status, height, weight, smoking/alcohol use, bone fracture history, family history of osteoporosis, calcium/multivitamin use, age of epilepsy diagnosis, number of AEDs presently taken, seizure frequency, insurance status, prescription coverage and driving status. Missing demographics items were gathered from the clinic chart when necessary.

Data analysis plan

The analytic plan of this study followed a specific progression. To simplify analyses stages were combined; stages 1 and 2 were defined as *unaware/unengaged*, stages 3—6 defined as *deciding/acting* and stage 7 defined as *maintenance*. This decision was made due to the distribution of persons (some stages had very few people) and for the purposes of more meaningful statistical analysis (see Table 1). While not consistent with the model this strategy has been utilized by other researchers.[31,38,39,58]

Descriptive statistics were determined first. Analysis of variance was used to examine the relationship between stage and the predictor variables (health belief scales, knowledge and self-efficacy). Then, we performed a bivariate (Pearson correlations) analysis to examine relationships between the dependent and independent variables as well as to identify redundancy among independent variables. Correlations provided insight into the variables that would likely hold up in the multivariate discriminant analysis.

Stepwise discriminant analysis was used to determine which predictors had independent effects on the stage classification. This helps in identifying

Table 1 Distribution among stages of the Precautionary Adoption Process Model by 4 osteoprotective behaviors

Stage	*n* (%)			
	Ca diet	Ca supplements	Exercise	DEXA
1. Unaware	8 (8.5)	9 (9.6)	12 (12.8)	20 (21.3)
2. Unengaged	22 (23.4)	21 (22.3)	9 (9.6)	8 (8.5)
3. Deciding	1 (1.1)	2 (2.1)	1 (1.1)	2 (2.1)
4. Decided against	9 (9.6)	6 (6.4)	7 (7.4)	4 (4.3)
5. Decided to act	5 (5.3)	2 (2.1)	15 (16.0)	6 (6.4)
6. Acting	11 (11.7)	13 (13.8)	15 (16.0)	14 (14.9)
7. Maintenance	35 (37.2)	40 (42.6)	33 (35.1)	37 (39.4)
Missing	3 (3.2)	1 (1.1)	2 (2.1)	3 (3.2)

Ca: calcium, DEXA: dual energy X-ray absorptiometry.

Table 2 Demographics of participants

Variables	*n* (%)
Female	66 (70)
Ethnicity	
Caucasian	50 (53)
African American	32 (34)
Latino	12 (13)
Marital status	
Single	48 (51)
Married	33 (35)
Separated/divorced/widowed	13 (14)
Employment status	
Full time	26 (28)
Part time	11 (12)
Not working	57 (61)
Yearly income	
Under $ 10,000	29 (31)
$ 10,000—30,000	24 (26)
Greater than $ 30,001	22 (23)
Missing	19 (20)
Has prescription coverage	72 (77)
On medical assistance	36 (38)
Presently has a driver's license	38 (40)
Body mass index	
Underweight	3 (3)
Normal	32 (34)
Overweight	18 (19)
Obesity	40 (43)
Reports cigarette use	13 (14)
Reports alcohol use	14 (15)
History of fracture	37 (40)
Diagnosed with bone loss	24 (26)
Taking an osteoporosis Medication	13 (14)
family history of osteoporosis	17 (18)
Presently taking calcium	41 (44)
Presently taking a multivitamin	60 (64)
Last reported seizure	
Within last 1 month	42 (45)
Between 2 and 12 months	27 (29)
Greater than 12 months	25 (26)
Present number of AEDs	
One	46 (49)
Two	33 (35)
Three	13 (13)
Four	1 (2)

which health behaviors variables are most likely to predict stage of behavior change. Potential confounders such as age, gender, ethnicity, income, medical assistance status, family history and fracture history were also evaluated. Discriminant functions are uncorrelated dimensions along which groups differ reliably. The functions indicate which specific variables predict differences between individual groups, the first function provides the best separation among groups.[43] Canonical discriminant analysis was used to derive the linear combinations of the variables that best explained the between stage variation.

Results

Demographics

This was an adult epilepsy population with a mean age of 45 years (S.D. = 12.9, range 19—78), there were 28 males and 66 females. These individuals included both young and old individuals and those newly diagnosed with epilepsy. Surveys were given to 98 Caucasians (44%), 85 African Americans (38%), 34 Latinos (15%) and 6 Asian/other (<1%). More women[66] completed surveys than men[28] which was not unexpected since women represented 61% of the outpatient database. Fifty subjects were Caucasian, 32 were African American, and 12 were Latino. The average length of antiepileptic drug (AED) exposure was 20 years (S.D. = 13.9, range 1—50). All demographic variables are displayed in Table 2.

Health beliefs

Based on one-way ANOVA for adoption of dietary calcium, persons in the maintenance stage had greater knowledge for exercise ($F = 7.41$, $p = .001$) and calcium ($F = 4.06$, $p = .021$) as well as greater perceived susceptibility ($F = 3.72$, $p = .028$), see Table 3. For the adoption of calcium supplements, those in maintenance had higher calcium knowledge scores ($F = 4.47$, $p = .014$) as well as greater perceived susceptibility ($F = 8.55$, $p = .000$). For the adoption of exercise, persons in maintenance had higher scores for knowledge related to exercise ($F = 7.30$, $p = .001$) and calcium ($F = 5.05$, $p = .001$), perceived benefits of exercise ($F = 7.30$, $p = .001$) and health motivation ($F = 4.35$, $p = .016$), as well as lower levels of perceived barriers for exercise ($F = 4.71$, $p = .011$) and calcium ($F = 5.05$, $p = .008$). Individuals in the maintenance stage for the adoption of DEXA screening had higher knowledge scores for exercise ($F = 3.40$, $p = .038$) and calcium ($F = 3.96$, $p = .023$) as well as greater perceived susceptibility ($F = 3.85$, $p = .025$).

Self-efficacy

Higher levels of self-efficacy for exercise ($F = 3.43$, $p = .037$) and calcium ($F = 5.71$, $p = .008$) were found for those in the maintenance stage for dietary

Table 3 Osteoporosis Health Belief Scales by recoded precaution adoption process stage (mean scores (S.D.))

	Frequency	OKT exercise	OKT calcium	Susceptibility	Seriousness	Benefits exercise	Benefits calcium	Barriers exercise	Barriers calcium	Health motivation
Calcium diet										
Unaware/unengaged	30	6.0 (3.1)***	6.8 (3.4)*	16.7 (4.5)*	19.5 (5.0)	22.3 (3.3)	22.6 (3.6)	14.5 (5.1)	15.1 (4.0)	22.3 (4.2)
Deciding/acting	26	6.7 (3.4)***	8.2 (3.9)*	19.2 (4.7)*	19.5 (4.2)	21.6 (4.9)	23.1 (4.2)	15.8 (9.7)	14.1 (4.8)	22.6 (4.5)
Maintenance	35	8.9 (2.9)***	9.3 (3.2)*	20.1 (6.0)*	18.7 (4.6)	23.3 (3.7)	23.4 (3.4)	12.6 (5.1)	12.7 (4.7)	24.5 (3.1)
Calcium supplements										
Unaware/unengaged	30	6.2 (3.1)	6.5 (3.6)*	15.7 (4.5)***	19.4 (4.6)	21.8 (4.0)	22.3 (3.5)	15.0 (4.6)	15.4 (4.2)	22.8 (4.3)
Deciding/acting	23	7.8 (3.2)	8.6 (3.3)*	18.8 (5.2)***	19.5 (4.6)	23.0 (4.7)	23.7 (4.0)	15.9 (10.6)	14.3 (4.6)	23.2 (5.0)
Maintenance	40	7.7 (3.5)	9.0 (3.6)*	20.7 (5.3)***	19.0 (4.7)	22.9 (3.5)	23.5 (3.6)	12.6 (4.8)	12.8 (4.5)	23.5 (3.0)
Exercise										
Unaware/unengaged	21	5.1 (3.2)**	5.8 (3.0)***	18.6 (4.4)	20.2 (4.9)	19.9 (3.5)***	23.5 (3.9)	16.4 (5.6)*	16.5 (4.0)**	21.5 (3.7)*
Deciding/acting	38	7.6 (3.2)**	8.3 (3.5)***	19.3 (5.2)	19.6 (5.1)	22.6 (4.0)***	22.3 (4.1)	15.3 (8.6)*	13.3 (4.6)**	22.9 (4.1)*
Maintenance	33	8.2 (3.2)**	9.4 (3.6)***	18.2 (6.0)	18.3 (3.8)	23.9 (3.6)***	23.3 (3.6)	11.4 (3.7)*	12.9 (4.3)**	24.6 (3.5)*
DEXA										
Unaware/unengaged	28	6.1 (3.3)*	6.9 (3.2)*	16.5 (4.0)*	19.5 (5.1)	21.6 (3.7)	23.2 (3.5)	13.8 (4.9)	14.4 (4.3)	22.8 (4.7)
Deciding/acting	26	7.3 (2.8)*	7.9 (3.2)*	19.4 (4.5)*	20.0 (4.8)	22.3 (4.5)	22.8 (3.6)	16.8 (9.9)	14.6 (4.7)	23.9 (3.4)
Maintenance	37	8.2 (3.5)*	9.3 (3.9)*	19.9 (6.3)*	18.4 (4.1)	23.3 (3.7)	23.2 (3.9)	12.6 (4.8)	13.1 (4.7)	23.0 (3.7)

Note: Precaution adoption stages were recoded as: Stages 1 and 2 = 1 (unaware/unengaged), Stages 3–6 = 2 (deciding/acting) and Stage 7 = 3 (maintenance).

* $p \leq .05$.

** $p \leq .01$.

*** $p \leq .001$.

Table 4 Self-efficacy scales by recoded Precaution Adoption Process Stages[a] (means (S.D.))

	Frequency	OSES calcium[b]	OSES exercise[c]	ESES[d]
Calcium diet				
Unaware/unengaged	30	60.4 (27.2)**	59.4 (26.4)*	248.6 (50.0)
Deciding/acting	26	67.4 (30.8)**	63.5 (30.2)*	244.7 (54.1)
Maintenance	35	80.7 (20.0)**	74.9 (18.2)*	261.8 (41.1)
Calcium supplements				
Unaware/unengaged	30	63.0 (25.4)*	62.6 (24.9)	257.6 (38.3)
Deciding/acting	23	66.2 (31.0)*	61.6 (30.4)	246.9 (60.9)
Maintenance	40	78.7 (23.6)*	72.0 (21.6)	252.1 (46.4)
Exercise				
Unaware/unengaged	21	58.7 (24.9)*	55.8 (28.7)	230.0 (36.6)
Deciding/acting	38	68.8 (29.8)*	69.3 (24.4)	257.5 (49.4)
Maintenance	33	79.1 (22.3)*	70.3 (23.4)	257.4 (54.6)
DEXA				
Unaware/unengaged	28	60.1 (28.3)	64.2 (23.1)	236.0 (52.5)
Deciding/acting	26	76.5 (23.8)	66.9 (29.2)	263.2 (41.4)
Maintenance	37	73.4 (26.7)	68.0 (25.1)	257.6 (46.9)

[a] Precaution Adoption Stages recoded as: Stages 1 and 2 = 1 (unaware/unengaged), Stages 3—6 = 2 (deciding/acting) and Stage 7 = 3 (maintenance).

[b] Osteoporosis Self-Efficacy Scale calcium: measures level of confidence (0—100) in undertaking osteoporosis prevention measures related to dietary calcium.

[c] Osteoporosis Self-Efficacy Scale exercise: measures level of confidence (0—100) in undertaking osteoporosis prevention measures related to physical exercise.

[d] Epilepsy self-efficacy scale: measures level of confidence (0—330) for managing epilepsy in the areas of medication management and seizure control.

* $p \leq .05$.

** $p \leq .01$.

calcium (see Table 4). Self-efficacy related to calcium was significantly higher for those in the maintenance stage for calcium supplements (F = 3.50, p = .034) and exercise (F = 3.98, p = .022). For the adoption of DEXA screening no significant differences related to self-efficacy were found. There were no significant differences in the epilepsy self-efficacy scale among any of the four osteoprotective behaviors.

Bivariate analysis

Chi-square analyses were performed for adoption stages and age (18—34, 35—49, and >50), gender and ethnicity (Caucasian versus non-Caucasian). Only age with older respondents being in higher stages for calcium supplement adoption (χ^2 = 16.11, p = .003) and ethnicity with Caucasians in higher stages for DEXA screening adoption (χ^2 = 10.47, p = .005) were significant.

The osteoporosis knowledge test calcium was positively correlated with all four osteoprotective behaviors assessed by the PAPM (see Table 5). For the osteoporosis knowledge test exercise subscale; calcium diet, exercise and DEXA were positively correlated. Susceptibility was positively correlated with dietary calcium, calcium supplements and DEXA screening. No correlations were seen with seriousness or perceived benefits for calcium. Perceived benefits of exercise were only correlated with the adoption of exercise. Barriers for calcium were negatively correlated with dietary calcium, calcium supplements and exercise, while barriers for exercise were negatively correlated with exercise adoption. Health motivation was correlated with dietary calcium and exercise. Self-efficacy for calcium was correlated with all osteoprotective behaviors except DEXA screening. Self-efficacy for exercise was correlated with dietary calcium adoption. Self-efficacy for epilepsy was not correlated with any of the osteoprotective behaviors assessed by the PAPM.

Discriminant analysis

Stepwise discriminant analysis revealed two significant independent predictors for dietary calcium stage: the knowledge test for exercise $F(2, 70)$ = .895 and calcium self-efficacy $F(2, 70)$ = .898. When these variables were entered into the canonical discriminant analysis, the full model was significant (Wilks' λ = .788, exact $F(4, 138)$ = 4.36, p = .002). The first discriminant function explained 96.8% of the variance among participants in different stages of the precaution adoption process. Stage

Table 5 Correlations among study variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Knowledge																
1. OKT calcium	—															
2. OKT exercise	.83***	—														
Health beliefs																
3. Susceptibility	.23*	.12	—													
4. Seriousness	−.28**	−.13	.14	—												
5. Benefits calcium	.08	.10	−.01	.27**	—											
6. Benefits exercise	.33***	.43***	−.03	−.05	.30**	—										
7. Barriers calcium	−.47***	−.42***	.01	.31**	.04	−.21*	—									
8. Barriers exercise	−.27**	−.21**	−.01	.15	.03	−.21*	.46***	—								
9. Health motivation	.06	.09	.06	.04	.12	−.14	−.12	−.14	—							
Self-efficacy																
10. Calcium	.06	.04	.13	−.03	.24*	.15	−.19	−.22*	.30**	—						
11. Exercise	.19	.15	.09	−.16	.06	.21*	−.20	−.36***	.27**	.58***	—					
12. Epilepsy	.19	.20	−.03	−.27**	.01	.17	−.17	−.01	.18	.32**	.35***	—				
Precaution Adoption Process																
13. Calcium diet	.29**	.37***	.27**	−.08	.09	.11	−.22*	−.12	.24*	.32**	.26*	.12	—			
14. Calcium supplements	.28**	.18	.40***	−.04	.13	.11	−.25*	−.17	.07	.26*	.17	−.04	.51***	—		
15. Exercise	.36***	.33***	−.05	−.16	.00	.37***	−.28**	−.29**	.30**	.29**	.20	.19	.33***	.30**	—	
16. DEXA	.29**	.28*	.26*	−.11	.01	.19	−.13	−.09	.01	.20	.06	.18	.46***	.50***	.23*	—

* $p \leq .05$.
** $p \leq .01$.
*** $p \leq .001$.

Table 6 Standardized discriminant function weights for Predictors of Precautionary Adoption Stage

	Standardized discriminant function weights							
	Calcium diet		Calcium Supp		Exercise		DEXA	
	1 [a]	2 [a]	1 [a]	2 [a]	1 [a]	2 [a]	1 [a]	2 [a]
Age	—	—	.427	.001	—	—	.767	−.642
Gender	—	—	—	—	—	—	—	—
Ethnicity	—	—	—	—	—	—	—	—
Education	—	—	—	—	—	—	—	—
Yearly income	—	—	—	—	—	—	—	—
Medical assistance	—	—	—	—	—	—	—	—
Family history	—	—	—	—	—	—	—	—
Fracture history	—	—	—	—	—	—	—	—
OKT calcium	—	—	—	—	—	—	—	—
OKT exercise	.661	−.751	—	—	.641	.767	—	—
Susceptibility	—	—	.641	−.682	—	—	.594	.804
Seriousness	—	—	—	—	—	—	—	—
Benefits calcium	—	—	.420	.791	—	—	—	—
Benefits exercise	—	—	—	—	—	—	—	—
Barriers calcium	—	—	—	—	—	—	—	—
Barriers exercise	—	—	—	—	—	—	—	—
Health motivation	—	—	—	—	.716	−.698	—	—
Calcium self-efficacy	.647	.762	—	—	—	—	—	—
Exercise self-efficacy	—	—	—	—	—	—	—	—
Epilepsy self-efficacy	—	—	—	—	—	—	—	—

Note: Dashes indicate that the variable was not included in the canonical discriminant function analysis. OKT: osteoporosis knowledge test, Supp: supplements; DEXA: dual-energy X-ray absorptiometry.
[a] Predictor.

means for this discriminant function increased consistently from the earliest stage (unaware/unengaged) to latest stage (maintenance). The standardized discriminant function weights shown in Table 6 indicate that OKT Exercise had the most effect on participant's scores on the first discriminant function. Rating higher on the knowledge of exercise for osteoporosis prevention was associated with higher discriminant function scores. The second discriminant function explained an additional 3.2% of the between stage variance. Subjects in the middle stage (deciding/acting) scored highest on this discriminant function, which reflects higher self-efficacy for obtaining calcium from diet or supplements.

Three significant independent predictors for calcium supplement stage: OHBS susceptibility $F(2, 70) = .822$, OHBS benefits calcium $F(2, 70) = .906$ and age (recoded) $F(2, 70) = .917$ were found. When these variables were entered into the canonical discriminant analysis, the full model was significant (Wilks' $\lambda = .65$, exact $F(6, 136) = 5.42$, $p = .000$). The first discriminant function explained 95% of the variance among participants in different stages of the precaution adoption process. The second discriminant function explained an additional 5% of the between stage variance.

Two significant independent predictors for exercise stage were found—health motivation $F(2, 70) = .853$ and OKT exercise $F(2, 70) = .878$. When these variables were entered into the canonical discriminant analysis, the full model was significant (Wilks' $\lambda = .748$, exact $F(4, 138) = 5.39$, $p = .000$). The first discriminant function explained 99.7% of the variance among participants in different stages of the precaution adoption process. The second discriminant function explained only an additional 0.3%.

Two significant independent predictors for DEXA stage: age recoded in categories $F(2, 70) = .835$ and OHBS susceptibility $F(2, 70) = .893$ were found. When these variables were entered into the canonical discriminant analysis, the full model was significant (Wilks' $\lambda = .748$, exact $F(4, 138) = 5.39$, $p = .000$). The first discriminant function explained 99.3% of the variance among participants in different stages of the precaution adoption process. The second discriminant function explained only an additional 0.7% of the between stage variance.

Discussion

This is the first study of persons with epilepsy to assess the Precaution Adoption Process Model and health behavior (knowledge, health beliefs and self-efficacy) in relation to AED induced osteoporosis.

The medical literature over the past 20 years has established a strong link between antiepileptic medications and metabolic bone loss[59]; however the emphasis has primarily been on determining which AEDs are worse for bone density in various populations. While clinical guidelines for practitioners in the epilepsy medical literature typically focus on evaluation of other risk factors, DEXA screening and general recommendations for exercise and supplementation[60] no one has attempted to assess the decision making process for these osteoprotective behaviors in epilepsy.

The discriminant function analysis found age to be a significant predictor of higher stages in the decision making process for calcium supplements and DEXA. Clinically, this makes sense as advancing age is typically the reason that calcium supplements and DEXA screening are recommended by healthcare professionals. The knowledge test for exercise was a predictor for higher stages of dietary calcium and exercise. This also makes sense in that dietary calcium and exercise are behaviors that require significant lifestyle changes from patients. Those who are highly motivated are likely to be able to make changes in both preventative areas. For these individuals, promoting exercise knowledge is more useful since they have made a commitment to change their behavior—those who are unaware or in the earlier stages of change are less likely to be motivated by action-based or knowledge-only interventions thus supporting the stages of change concept.

Based on the discriminant analysis, perceived susceptibility for osteoporosis and advancing age, are predictors of higher stages of calcium supplement use and DEXA screening. Therefore, providing information about risk appears to help the adoption of calcium supplements and for screening which holds with other models of health behavior such as the Health Belief Model. People are unlikely to take calcium supplements if they think it will not benefit them—supporting the fact that perceived benefits of calcium predict higher stages of adoption for calcium supplements.

Health motivation predicts higher stages of adoption for exercise, while not an unexpected finding also provides support for components of the Health Belief Model. Calcium self-efficacy is a predictor of higher stages of dietary calcium adoption—supporting the literature that higher levels of self-efficacy (confidence) are important for dietary change. Progressively higher levels of self-efficacy in the more advanced stages of change have been found in previous osteoporosis research,[33] by exercise researchers[43,61] and in diet studies.[36]

Based on the literature review of knowledge and health behavior, related to osteoporosis, much needs to be done to bridge the gap between patients and practitioners. Especially since most patients lack the skill or knowledge to evaluate their diet based on nutrient intake and therefore have little or no awareness of how their current behavior compares with a specified goal.[62] Persons with epilepsy, like other chronic health conditions, need effective communication from their healthcare practitioner. Stage-based education, for persons with epilepsy, tailored to improve self-efficacy may therefore help persons move people through the osteoprotective decision making process more effectively.

In patient care it is always of primary clinical importance to optimize seizure treatment by balancing the goal of seizure freedom with the potential adverse effects of medication, surgery and/or other treatments. Hence, until clinical care is stabilized, it is realistic to recognize that prevention is often a lower priority. Since epilepsy self-efficacy was not a predictor in any of the models or correlated with any of the stages of the PAPM it follows that effective communication about osteoprotective behaviors may be very different than that of epilepsy specific self-management. In light of the poor insight into their condition,[63] patient education efforts still need to enhance epilepsy self-management.

Previous research has found that exercise can improve seizure control in patients.[64] The lack of understanding among many health professionals about epilepsy must also be addressed since unnecessary restriction of physical activity can have a profound effect on bone health as well as mortality, morbidity and quality of life. Exercise participation recommendations should be reviewed with regards to seizure control, medications, proper diet, rest and the close monitoring of AED levels. If these aspects are taken into account, then persons with epilepsy can participate in most types of physical activity, including some contact sports.[65] Further examination of relapse and the reasons for it are needed since few people give up entirely, some think about exercising again and many reduce the amount they exercise.[61]

Interventions also need to focus on the need for relapse prevention among those who are presently consuming enough calcium.[66] Lactose intolerance, the perception that milk is for children, substituting soft drinks for milk, eating away from home, having few role models who drink milk and problems related to transportation and storage are barriers that have been documented to decrease milk consumption in non-Caucasian populations.[67] One area that may help improve education is the use of culturally relevant materials.

Medical training teaches health professionals to organize knowledge according to disease history, etiology, symptoms, treatment options and side effects. Therefore, most clinic-based educational materials are written in this ''medical model'' format. Patient materials that focus on facts only and use medical terms foreign to the general public are less effective.[68] These materials are not stage-based and often have little in the way of behavioral aspects, needed to improve self-efficacy. In addition, epilepsy clinic education materials (mostly provided by the pharmaceutical companies) are often written at a level that exceeds the readability of most patients.[69] Pictures, drawings or actors used in patient education materials need to represent various ages, genders, ethnic groups and body types so that patients can identify with them.

Stage models of health behavior are likely to be most accurate among people who have been exposed to the health issue recently in their daily lives.[37] While the availability of stages-based osteoporosis education materials is limited and results of trials have been mixed[41,70] there are strategies which health professionals can utilize. The use of open-ended questions are more effective at helping patient's identify barriers and potential solutions leading to increased self-efficacy. Clinic-based health educators and nurses knowledgeable of osteoprotective concepts may also help facilitate the adoption of osteoprotective behaviors.

The use of a brief assessment tool such as the one developed by Blalock et al.[71] may help practitioners assess patients' calcium intake within the short timeframe of an appointment. For people to become engaged in the behavior change process, they must not only become aware of a particular health problem and the recommended precautions, they must also know whether or not their current behavior meets the recommended guidelines.[66] Providing feedback to women about calcium intake decreased those in the unengaged stage by 23% in one prospective study of stage matched educational materials, while the action-based plan (stage 5 of the PAPM) was not associated with changes in knowledge or beliefs.[41]

Study limitations

Since patients at a tertiary academic medical center are often more refractory to treatment, the differences we found may be higher when compared with a well-controlled epilepsy population seen only by primary care. The overall response rate was low (42%) in our population. Since no stipend was offered this may have resulted in a lower than expected response rate. This may be also be due to the length of the survey. There were a total of 146 questions in the survey packet. Only five patients verbally declined to participate, but many more failed to return the survey despite being given a self-addressed stamped envelope. This may be due to issues of low literacy in our population. Several subjects were assisted after their clinic visit to overcome difficulties with readability. Opportunities to address this issue with those patients receiving a mailed survey are much lower. By combining stages in the statistical analysis we misclassified people based on the PAPM concept. However, despite the blurring of distinction between stages our analyses are consistent with the theoretical concepts within the stages of change concept. The use of a cross sectional study design also has its limitations.

Conclusions

Overall, this study adds to the understanding of knowledge, health behavior and self-efficacy related to the prevention adoption process in persons with epilepsy, a population at significant risk for bone loss and fractures. Previous studies of non-epilepsy populations have found that knowledge related to calcium or exercise were not predictors of behavior. However, in this study of persons with epilepsy it was found that knowledge of osteoprotective exercise is critical in later stages of adoption for exercise and dietary calcium. Age and perceived susceptibility were strong predictors of higher stages of calcium supplement use and DEXA screening.

One major challenge in epilepsy care is to enhance osteoprotective behaviors such as increased dietary calcium, calcium (with vitamin D) supplementation, exercise and DEXA screening in younger patients, a population who tend to not perceive themselves at risk for bone loss. In this study, persons who were unaware or unengaged perceived the lowest susceptibility for osteoporosis and those in maintenance the highest. In epilepsy care these extremes may be a majority of patients since previous studies indicated only 41% of pediatric and 28% of adult neurologists routinely evaluate AED-treated patients for bone mineral disease.[72] In addition, previous studies of person with epilepsy found 75% were unaware of bone loss as a side effect of their medication.[5] The results of this study indicate that neurologists and epilepsy specialists need to discuss osteoprotective behaviors with their patients. To capitalize on the opportunities addressed in this research the next step is to design and evaluate osteoprotective educational interventions for persons with epilepsy. By understanding issues important to patients and optimizing educational opportunities based on a stage-based model, such as the PAPM, we may find ways to be more successful at promoting the adoption of osteoprotective behaviors.

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